Amendments to the Claims

1. *(Original)* A method of frequency estimation for the downlink of wireless communication systems, comprising:
(a) according to the received radio signals, determining radio signals the phase shift of the midamble and that of the downlink synchronization code of the radio signals respectively;
(b) calculating the phase shift difference between the midamble and the downlink synchronization code of the radio signals, according to the determined phase shift of the midamble and that of the downlink synchronization code;
(c) estimating the frequency offset of the radio signals, according to the phase shift difference between the midamble and the downlink synchronization code of the radio signals and the relationship between the expected midamble and the downlink synchronization code.

2. *(Original)* The method of claim 1, wherein the relationship between the expected midamble and the downlink synchronization code is the time interval between the expected midamble and the downlink synchronization code.

3. *(Original)* The method of claim 2, wherein step (a) includes:
(a1) extracting the midamble of the radio signals from the radio signals;
(a2) acquiring the midamble used by the cell during cell search procedure;
(a3) correlating the midamble of the radio signals with the acquired midamble used by the cell, to determine the phase shift of the midamble of the radio signals.

4. *(Original)* The method of claim 3, wherein step (a) includes:
(a4) extracting the downlink synchronization code of the radio signals from the radio signals;
(a5) acquiring the downlink synchronization code used by the cell through cell search procedure;
(a6) correlating the downlink synchronization code of the radio signals with the acquired downlink synchronization code used by the cell, to determine the phase shift of the downlink synchronization code of the radio signals .

5. *(Original)* The method of claim 4, wherein step (b) includes:
(b1) conjugating the phase shift of the midamble of the radio signals;
(b2) multiplying the conjugate of the phase shift of the midamble by the phase shift of the downlink synchronization code;
(b3) acquiring the phase shift difference between the midamble and the downlink synchronization code of the radio signals from the multiplication result.

6. *(Original)* The method of claim 5, wherein the complex angle of the multiplication result is extracted through calculating trigonometric functions and the value of the complex angle is taken as the phase shift difference between the midamble and the downlink synchronization code of the radio signals, in step (b3).

7. *(Original)* The method of claim 5, wherein the multiplication result is converted into complex in unit amplitude and the imaginary part of the complex is taken as the phase shift difference between the midamble and the downlink synchronization code of the radio signals, in step (b3).

8. *(Currently Amended)* The method of ~~claim 6 or 7~~claim 6, wherein step (c) includes:

normalizing the phase shift difference between the midamble and the downlink synchronization code, to get the frequency offset of the radio signals, according to the time interval between the expected midamble and the downlink synchronization code.

9. *(Original)* An apparatus of frequency estimation for the downlink of wireless communication systems, comprising:

a determining unit, for determining, according to the received radio signals, the phase shift of the midamble and that of the downlink synchronization code of the radio signals respectively;

a calculating unit, for calculating the phase shift difference between the midamble and the downlink synchronization code of the radio signals , according to the determined phase shift of the midamble and that of the downlink synchronization code;

an estimating unit, for estimating the frequency offset of the radio signals, according to the phase shift difference between the midamble and the downlink synchronization code of the radio signals and the relationship between the expected midamble and the downlink synchronization code.

10. *(Original* The apparatus of frequency estimation in claim 9, wherein the relationship between the expected midamble and the downlink synchronization code is the time interval between the expected midamble and the downlink synchronization code.

11. *(Original)* The apparatus of frequency estimation in claim 10, wherein the determining unit includes:

a midamble acquiring unit, for extracting the midamble of the radio signals from the radio signals;

a first correlator, for correlating the midamble of the radio signals with the midamble used by the cell, to determine the phase shift of the midamble of the radio signals, wherein the midamble used by the cell is acquired through cell search procedure.

12. *(Original)* The apparatus of frequency estimation in claim 10, wherein the determining unit further includes:

a downlink synchronization code acquiring unit, for extracting the downlink synchronization code of the radio signals from the radio signals;

a second correlator, for correlating the downlink synchronization code of the radio signals with the downlink synchronization code used by the cell, to determine the phase shift of the downlink synchronization code of the radio signals, wherein the downlink synchronization code used by the cell is acquired through cell search procedure.

13. *(Original)* The apparatus of frequency estimation in claim 12, wherein the calculating unit includes:

a complex conjugate multiplier, for conjugating the phase shift of the midamble of the radio signals, and multiplying the conjugate of the phase shift of the midamble by the phase shift of the downlink synchronization code;

a phase shift difference calculating unit, for acquiring the phase shift difference between the midamble and the downlink synchronization code of the radio signals from the multiplication result.

14. *(Original)* The apparatus of frequency estimation in claim 13, wherein the phase shift difference calculating unit extracts the complex angle of the multiplication result by calculating trigonometric functions, and takes the value of the complex angle as the phase shift difference between the midamble and the downlink synchronization code of the radio signals .

15. *(Original)* The apparatus of frequency estimation in claim 13, wherein the phase shift difference calculating unit converts the multiplication result into complex in unit amplitude and takes the imaginary part of the complex as the phase shift difference between the midamble and the downlink synchronization code of the radio signals.

16. *(Currently Amended)* The apparatus of frequency estimation in ~~claim 14 or 15~~claim 14, wherein the estimating unit normalizes the phase shift difference between the midamble and the downlink synchronization code of the radio signals, to get the frequency offset of the radio signals, according to the time interval between the expected midamble and the downlink synchronization code.

17. *(Original)* A radio signal receiver, comprising:

a receiving unit, for receiving radio signals and converts the received radio signals into baseband digital signal;

a cell searching unit, for performing cell search procedure based on the received signal, to get the midamble and the downlink synchronization code used by the cell;

a frequency estimating unit, for determining the phase shift of the radio signals according to the received radio signals and the midamble and the downlink synchronization code used by the cell outputted by the cell searching unit;

a frequency generating unit, for adjusting the output frequency supplying to the receiving unit according to the inputted frequency offset information, so that the receiving unit can convert the received radio signals into baseband digital signal by using the adjusted frequency.

18. *(Original)* The radio signal receiver in claim 17, wherein the frequency estimating unit includes:

a determining unit, for determining, according to the received radio signals, the phase shift of the midamble and that of the downlink synchronization code of the radio signals respectively;

a calculating unit, for calculating the phase shift difference between the midamble and the downlink synchronization code of the radio signals , according to the determined phase shift of the midamble and that of the downlink synchronization code;

an estimating unit, for estimating the frequency offset of the radio signals, according to the phase shift difference between the midamble and the downlink synchronization code of the radio signals, and the relationship between the expected midamble and the downlink synchronization code.

19. *(Original)* The radio signal receiver in claim 18, wherein the determining unit includes:

a midamble acquiring unit, for extracting the midamble of the radio signals from the radio signals;

a first correlator, for correlating the midamble of the radio signals with the midamble used by the cell, to determine the phase shift of the midamble of the radio signals;

a downlink synchronization code acquiring unit, for extracting the downlink synchronization code of the radio signals from the radio signals;

a second correlator, for correlating the downlink synchronization code of the radio signals with the downlink synchronization code used by the cell, to determine the phase shift of the downlink synchronization code of the radio signals.

20. *(Original)* The radio signal receiver in claim 19, wherein the calculating unit includes:

a complex conjugate multiplier, for conjugating the phase shift of the midamble of the radio signals, and multiplying the conjugate of the phase shift of the midamble by the phase shift of the downlink synchronization code;

a phase shift difference calculating unit, for acquiring the phase shift difference between the midamble and the downlink synchronization code of the radio signals, by calculating trigonometric functions or converting the multiplication result into complex in unit amplitude.

21. *(Original)* The radio signal receiver in claim 20, wherein the estimating unit normalizes the phase shift difference between the midamble and the downlink synchronization code to get the frequency offset of the radio signals, according to the time interval between the expected midamble and the downlink synchronization code.

22. *(Original)* A Rake receiver, comprising:

a receiving unit, for receiving radio signals, and dividing the radio signals into a plurality of fingers of signals;

a plurality of frequency estimating modules, for estimating the frequency offset of each finger of signal respectively;

a weighting and combining unit, for weighting the signal outputted from each frequency estimating module and combining the weighted signal to get a frequency offset estimating signal containing frequency offset estimation result about each finger.

23. *(Original)* The Rake receiver in claim 22, wherein each the frequency estimating module includes:

a determining unit, for determining, according to the received radio signals, the phase shift of the midamble and that of the downlink synchronization code of the radio signals respectively;

a calculating unit, for calculating the phase shift difference between the midamble and the downlink synchronization code of the radio signals , according to the determined phase shift of the midamble and that of the downlink synchronization code;

an estimating unit, for estimating the frequency offset of the radio signals, according to the phase shift difference between the midamble and the downlink synchronization code of the radio signals and the relationship between the expected midamble and the downlink synchronization code.

24. *(Original)* A receiver with a plurality of antenna elements, comprising:

a receiving unit, for receiving a plurality of channels of radio signals via the plurality of antenna elements;

a plurality of frequency estimating modules, for estimating the frequency offset of each channel of radio signals respectively;

a weighting and combining unit, for weighting the signal outputted from each frequency estimating module and combining the weighted signals to get a frequency offset estimating signal containing frequency offset estimation result of each channel.

25. *(Original)* The receiver in claim 24, wherein each the frequency estimating module includes:

a determining unit, for determining, according to the received radio signals, the phase shift of the midamble and that of the downlink synchronization code of the radio signals respectively;

a calculating unit, for calculating the phase shift difference between the midamble and the downlink synchronization code of the radio signals , according to the determined phase shift of the midamble and that of the downlink synchronization code;

an estimating unit, for estimating the frequency offset of the radio signals, according to the phase shift difference between the midamble and the downlink synchronization code of the radio signals, and the relationship between the expected midamble and the downlink synchronization code.